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Logistics in the Health Sector

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Abstract

This project aims to analyse a hospital's logistic processes and to find strategies to improve it's efficacy. As a result of the literature review and the study of Faro Hospital's practices, it was possible to make some proposals, leading to a more efficient use of the resources. Consignment contracts with the suppliers, to use an existent hangar as the unique consumption materials' warehouse, employ inventory management techniques widely used in other industries and create advanced warehouses inside the main hospital departments, are the key recommendations of this project. These ideas can be applied to other hospitals, helping to reduce costs and improve levels of quality in the health sector.

Keywords: Supply chain, logistics, hospital, clinical consumption materials.

1. Purpose of the Project

The purpose of this project is the study of hospitals' supply chain management and related logistics activities, since these areas are vital for any industry. Nevertheless, in the health care industry, in particular, there is little research about this theme. Specially in the field of management of clinical consumption materials. Even though they are not expensive, when there is a lack in certain products there can be a blockage in the hospital's normal activity.

This industry is facing many problems, both at financial and structural levels. Therefore, it is vital to find new management techniques that can be applied, to improve productivity and quality, increase the professional satisfaction, eliminate waste, and reduce costs.

In this context, it is natural that managers are mainly focused on the hospital production and in the human resource management that are the main sources of hospital expenses. Following these, comes the supply function which is responsible for the second larger parcel of the total annual costs, with a relative weight of 30% (Gonçalves, 2001). The supply chain function includes the purchasing, the procurement and the formalism that needs to be followed, regarding the budget constraints.

The area of management and distribution of materials, given the importance that have in the hospital budget, seems a good field of analysis and intervention in the research of new solutions that can contribute to maximise the available resources.

The logistics of pharmaceutical products has been object of several studies and investigations, and it has suffered many improvements over the years. This may happen because they represent a large portion of the total costs of the supply function, or

because they are homogeneous products in shape and size that have many enterprises behind with the same objective: to reach the patient at the lowest cost.

The same does not occur with the clinical consumption materials, which are less expensive than the pharmaceutical products, but even so represent 25% to 35% of the total expenses of the supply function. The management of this materials is, comparatively, less investigated, which can be due to differences in terms of prices, inventory turnover or suppliers.

In order to correct, somehow, this situation, this project aims to answer the question "how it is possible to improve the management of clinical consumption materials in hospitals?".

The methodology used to answer this question, was in a first stage to do an extended bibliographic research in the area of the supply chain and, in particular, in the inventory management and the distribution processes of clinical consumption materials. The second stage was to study and analyse the supply function of a hospital. For this purpose, the Faro Hospital was chosen and, more specifically, the cardiology department as example of all other departments. In this stage contacts were also made with both professionals in the health and logistics areas.

After gathering all the information and comparing different methods of management and distribution, it can be concluded that it is possible to improve the current logistic system in Faro Hospital not only by adopting new IT, for instance, the bar codes, but also by reviewing some practices and processes. These conclusions are important because they can be applied in other hospitals that suffer from the same problems.

2. Literature review

In order to facilitate the understanding of this work, it is important to define clearly the following concepts: **supply chain management**, **logistics** and **inventory management**.

"**Supply Chain Management** is the integration of all activities associated with the flow and transformation of goods from raw materials through to end user, as well as information flows, through improved supply chain relationships, to achieve a sustainable competitive advantage." *Handfield and Nichols* (Balou, 2004)

"**Logistics** is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements." *Council of Logistics Management* (Balou, 2004).

"**Inventory management** are the policies, procedures, and techniques employed in maintaining the optimum number or amount of each inventory item. The objective of inventory management is to provide uninterrupted production, sales, and/or customer-service levels at the minimum cost. Since, for many firms, inventory problems can and do contribute to losses or even business failures. " (Business Dictionary, 2009)

Logistics has always been considered fundamental in every business, but in the public health care industry only now logistics began to be considered important. Hospitals' core business is the treatment of patients and all other activities were considered secondary, not deserving so much attention, but recently the logistics processes in hospitals have been an area of concern because they can improve the productivity and the quality, making all the processes more efficient. How to adapt the logistics techniques to the hospital reality is a question that many authors are trying to answer (Gonçalves, 2001).

Jarret (1998) defends that, if hospitals want to remain competitive in this new environment, where costs are rising and the services provided to patients must be the best, innovation must be the fundamental issue. Since the introduction of managed care, the health care industry began to be more concerned about the cost analysis of their procedures. In the past, all health care providers were reimbursed for the costs of their business, which is treating patients, so there was no incentive to know the price of the services provided. Due to this new scheme of managed care, there is an incentive to reinvent the supply chain management practices and apply new models of logistics.

There are authors that defend the transfer of just-in-time (JIT) philosophy to hospitals (Heinbuch, 1995), but health care providers do not agree with that because it's very difficult to predict the production capacity, that is, the ultimate patient mix. On the other hand, it is also difficult for other industries to predict and schedule the production, but it is possible to adapt flexible techniques for a successful implementation of JIT (Jarret, 1998). Therefore, it is also possible for hospitals to contradict its traditional practices of order and store large quantities of products at each time, and adopt the JIT philosophy.

Also related with inventory management, there is one approach that defends that all the logistics processes should be scheduled and coordinated to avoid stockouts and to have all the resources available without inventory in excess (Lapierre and Ruiz, 2005).

Kumar (2008), in a study made to Singapore hospitals identified that the outsourcing is a potential area for integrating supplies with other hospitals, specifically in the sterile supplies, although outsourcing may not always reduce the costs of services (Moschuris, 2006). In another study to Singapore hospitals, Pan (2007) realized that the purchasing of common items was being done through a central unit, what is considered to be positive as the bulk purchases can achieve easily economies of scale; meanwhile the

specific items were bought by individual hospitals which assure better quality control and service level.

Regarding to the purchasing decisions, hospitals still not take into account the logistical components of packaging (Kumar, S. 2008), as they do not value packaging as an essential variable when thinking in a more efficient inventory management. There are many opportunities for improvement in the packaging industry, such as the implementation of standardize tracking methods like bar codes and radio frequency identification devices (RFID) that will turn the inventory management more effective and without errors.

3. Hospital clinical consumption materials' supply chain management

There are different issues that can arise in the context of logistics and supply chain management. This section will explore sequentially the negotiation process, the warehousing, the inventory management , the picking and the internal distribution of clinical consumption materials. Each theme begins with a theoretical introduction, that is followed by an analysis of the practises at Faro Hospital, in the end of each section, a purpose is made with the objective of improving the current practices.

3.1 The supply in a wide sense

There is a wide range of different products and suppliers in a hospital. In this context there are groups of materials that have more financial importance than others. It is also possible to classify the products regarding the supply market, considering the difficulty in finding the products in the market, and if there are many suppliers or just one. Conciliating these two dimensions it is possible to understand that the clinical

consumption materials can be very heterogeneous between them. Ranging from diapers and syringes to pacemakers and stents, the quantities used, the number of suppliers and the unit price, are different, so a specific management rule for each group of products has to be applied.

The main idea is that the products are different in price, inventory turnover and suppliers, so the management of each group of products should take into consideration these differences, instead of considering the respective supply chains equal and uniform.

3.2 The negotiation process

This section includes all the steps since the selection of the suppliers, its evaluation, the public contest until the signature of the contract.

There are many questions that can be made at this level regarding health care providers and its potential suppliers. In the past, public health institutions did not have the same freedom to choose its suppliers like they do today, they had to follow a list where the prices of products were already establish and it was the same for every health institution, so negotiation did not exist. Today, with the emergence of private health care institutions and due to the fact that public hospitals have become public enterprises, cost issues are becoming more relevant. The market has evolved and became more dynamic in terms of negotiation, but most of the health institutions have failed to perceive this change.

As a public enterprise, Faro Hospital has to act in accordance to the law (Decreto-lei nº18 2008, de 29 de Janeiro, Códigos dos Contractos Públicos). For instance, to purchase products or services above 206.000€, the hospital must organise an international contest, allowing all the enterprises to make an offer, which is important in

order for competition and transparency to exist. Then the hospital chooses the supplier that made the most advantageous economic offer, taking into account the quality of the product, the price, the technical merit, the time of delivery, and the opinion of the users.

Evidently, product's parameters like price, quality, lead times and technical merit are important factors when choosing a supplier, but there are other parameters that can be negotiated and, usually, health care providers do not have them into account. The terms of payment, the quantities delivered each time, the place of delivery, and the responsibility for the delivery are all elements of service that can be negotiable. These specifications are important because they can compromise the supply chain system and commit the performance of the health care provider, both in terms of costs and service, which can affect the client's satisfaction.

If these parameters are not present in the contract they can not be negotiated and taken into account when choosing the best suppliers. When suppliers try to answer the problems of the client, new models and practices are created, improving the performance of the system, reducing the costs and improving the quality.

In Faro Hospital there is a good example of a win-win negotiation. The doctor responsible for doing the angioplasties, with the aim of getting better prices for the stents (tubes that are placed in the coronary arteries during an angioplasty), as they are very expensive, made an agreement with the supplier that produces the best quality stents in the market. The doctor makes a prediction of how many stents he will need during the following year and negotiate with the supplier the terms of payment and the price, depending on the quantity required. Instead of buying all the needs for one year at once, he decided to have these products in consignment. Moreover, the supplier agrees to deliver the product in two days, making it possible to maintain a minimal inventory

level in the hospital, with high product availability at reasonable costs. The advantages of consignment, in terms of costs, are more relevant when the products are more expensive. This can be considered as a partnership, the supplier has a contract to deliver during a year, a certain quantity, and the client has always the right number of product, at the right time, at the right place and at the lowest cost.

Consignment nowadays, is becoming a current practice in hospitals in particular for very expensive products as stents and prostheses. Nevertheless, consignment could be extended to other products.

Proposal I
More consignment contracts with suppliers should be made in order to get better prices and conditions. Group Purchasing Organisations (GPO) are also a good solution to achieve economies of scale, Faro Hospital could join with some health care institutions and create a GPO to purchase common items.

3.3 The warehouse

In the warehouse, the layout and the storage of the products are critical issues when talking about inventory management.

The warehousing should be a competitive advantage rather than a problem in health institutions; the timings, the way of displaying the materials inside the warehouse, the reception of the products and its storage in the appropriate location should be thought to be the most efficient possible.

Is it important to consider the existence of a central warehouse or many warehouses? Should the pharmaceutical warehouse be integrated with the clinical consumption warehouse, the non-medical items warehouse and stationers? This kind of questions are important in a logistics sense. Although all the warehouses can be considered to work in

the same way, since all the products go through the same processes (they enter, remain and exit the warehouse), not all the products are identical in terms of distribution, and this should also be taken into consideration when deciding the total number of warehouses that a hospital should have. The medicines are distributed in individual doses, the clinical consumption materials are distributed for reposition of advance warehouses for example, and non medical items like printers have other specifications. One solution might be making a big central warehouse but taking in account the specifications of each family of products, standardising some of the identical processes.

Ideally the stock holding points should be the least possible, which reduces inventory carrying costs, warehousing costs and, allows economies of scale in the process.

The logic of the warehouse's layout should be the simplest possible, as well as efficient, which implies less movements, reduces the timings of the routes when storing or picking the products and brings more fluidity to the whole process. A fundamental aspect is to have different places for the reception of the products, when the suppliers make the deliveries, and for the preparation of the products to expedition, when the internal deliver to the medical departments is done. Moreover, it is important to optimise all the space available in the warehouse by using mobile storage systems, for instance, and also by taking advantage of the space in height.

The logic of storage is also important, the products that have less rotation should be situated in the back of the warehouse and the products with more rotation must be more accessible, closer to door.

Each storage place, either a shelf or a box, should be identified by a number or a code. This way, to each position there is a type of product associated, making the localisation easier

Most of Portuguese hospitals have not yet adopted these techniques and technologies. Using Faro Hospital as an example, it is possible to say that in terms of warehouse it has much to improve. Faro Hospital was built in the 70's, at that time warehouses and logistic activities were not important to hospitals. As a result, a central warehouse was not planned and, therefore, the space where the clinical consumption materials' warehouse is situated today has a lot of constraints in terms of area and mobility.

In total there are 8 warehouses in this hospital: the clinical consumption materials, the pharmaceutical, the administrative, the material for conservation, the reagent laboratory, the blood department, the food items and the linen and uniforms.

The clinical consumption materials warehouse is situated in a wing of the hospital opposite to the entrance of the visitors. Moreover, it is strategically positioned not only because it facilitates the reception of the supplier's products, since it is near to the hospital's entrance, but also due to the internal delivery of the products, that is made through a route inside the building were the departments are located. These are the only two strengths of the warehouse.

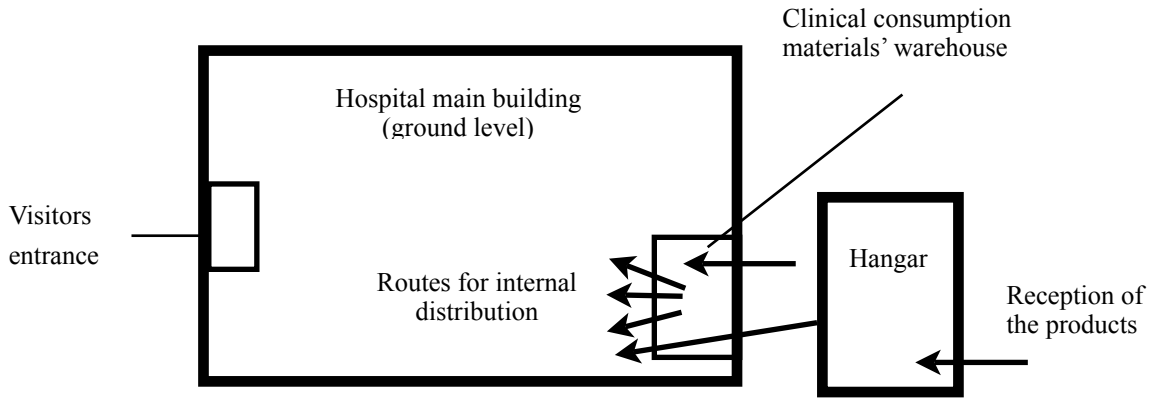

Figure 1: Localisation of the clinical consumption materials' warehouse

The layout of the warehouse has some drawbacks. For instance, there is only one point for the entrance and exit of the products, creating congestion at busy hours and the total space of the warehouse is not being fully explored. If, say, higher shelves or mobile

storage systems were used, the space would be optimised. In addition, the routes that the workers have to do when storing or picking the materials are not the more efficient ones, nor the fastest because they are not facilitated by the correct identification of each place to each product.

Figure 2: Storage in the clinical consumption materials' warehouse. Source: HF, EPE

Another difficult with the warehouse is that, as the space is not enough, many of the products are stored outside the warehouse. This is not a good practice, especially for the bulkier materials that have a high rotation and are supposed to be stored close to the door, as diapers, for example.

Figure 3: Products outside the warehouse. Source: HF, EPE

In an effort to surpass the problem of lack of space a hangar was built in order to store the bigger materials that did not fit in the warehouse. However, this hangar is not being completely used, since there are no shelves and the materials just lay on the floor.

Figure 4: Hangar. Source: HF, EPE

There is also a problem related with the reception of the products. When a product is received, beyond from laying on the floor waiting for someone to store it (physical flow), is only registered when a person enters the data on the information system (information flow),which can take hours. This same worker also has to register the exit of the products from the warehouse, this mean that the stocks can be outdated.

Figure 5: Products waiting to be stored. Source: HF, EPE

All types of materials are delivered in the clinical consumption materials warehouse, even those that belong to other warehouses. Consequently, when they receive these misplaced materials, the products lay on the floor, waiting for someone to pick them up, as that is not the correct place for them to be stored.

Another problem are the advanced warehouses; in this hospital there are small warehouses in each department, that are not considered advanced warehouses, but this issue will be discussed later.

Proposal II
To use the existent hangar as the unique clinical consumption materials' warehouse. The hangar has an area big enough to store all the materials, but some adjustments need to be done; shelves and lights must be installed. The hangar should have a point of entrance and another of exit to optimise the process.

3.4 Inventory management

Inventories are constituted for different functions, like buffers between purchases and production in the different stages of production and between production and sales, security, anticipation and economic control.

The inventory can represent an important asset of the companies and, usually, its management is developed at three levels: administrative, material and economic.

The administrative management includes the tasks of identification, classification and registration of the administrative movements of the products, from entry to exit of the product in the warehouse. The material management is responsible for the form, local and process of warehousing used for each article. The economic management, with the objective of minimising the costs of possession of inventory, maintaining the service level, deals with decisions like: which products should be kept in stock? How much (stock level)? and What should be the size of the order? (Almeida, 2002).

The ABC analysis is a fundamental tool of inventory management optimisation, that basically, identifies the products that are more important from the customer point of view, for instance, in terms of spending value, allowing different options and decisions. This analysis is based on the Pareto law, or the 20x80 law, that means that, in empirical

terms and on average, 20% of the used items accounts for 80% of the total spending value.

Furthermore, there are other techniques of management that can be useful to inventory management like the JIT and the *Kanban*. These systems were developed in Japan, both defend that maintaining inventory is a waste of resources and does not add value. The philosophy of JIT is all about having "*the right material, at the right time, at the right place and in the exact amount*", without the need of a safety inventory (Jarret, 1998). Kanban is Japanese word that literally means "card" and whose origin is associated with the Toyota Production System. Is a method used in very repetitive production systems, where the products are standardized and the demand is acceptably stable. It assumes that the production system is organized in flux, where the rhythm of production is determined by the rate of movement of the kanbans, which in turn is determined by rhythm of consumption of products. Basically, the kanban acts as a order between the different lines of production and, as a shipping document that goes along with the products that resulted from that order.

It is possible to adapt these systems to the reality of hospitals. Many authors defend that it is possible and crucial to adopt the JIT in hospitals but with the necessary modifications, as hospitals need to maintain a safety stock for the emergency cases and it is also very difficult to predict the ultimate patient mix. By adopting this system, hospitals will have to reduce drastically its stocks and will have to change their relations with the suppliers. They must also develop partnerships, only this way it is possible to achieve positive results and improve the service quality (Heinbuch, 1995).

Establishing a parallelism with the hospital reality where effective production does not exist, the Kanban serves to give an order of picking in the warehouse as the products are

being consumed in the diverse departments. It is possible to transfer this system to a hospital not only because although there is a wide range of products, it is limited, but also because the consumption of the products presents a similar behavior in weekly homologous periods. In accordance with the consumptions, a point of order for each product is determined, the kanban (card) with all the necessary information, is placed between the stock creating a point of order. At the time the kanban is reached, it is necessary to make a new order, so the card is placed in the "box of products to order" and the responsible for the orders proceeds to order the material. When the order is completed, the card is placed in the "box of ordered products" until the supplier makes the cited delivery. From this point the kanban goes with the respective product to its specific local of storage, the card is placed in the order point (Pinto, 2008).

The Kanban method is currently being applied in many hospitals, but the difference is that is called *e-Kaban* because is supported by information systems that turns the process even more efficient and free of mistakes. Basically, this method of inventory management creates levels for the different types of products which need to be satisfied when reach a determined point, the more difficult is calculate the exact level. This method could be very useful to eliminate waste and turn all the process easier and effective.

Today, the major problems that hospitals face related with the inventory management are of economical nature. Hospitals maintain stocks of an uncountable number of products, they have a lot of references and suppliers for the same product, this need to be reviewed. It is possible that many dispensable materials, for some reason, continue to be purchased and maintained in stock.

In this context, there are also cases where the same product has many references. The same product is bought from more than two different suppliers, which is comprehensible as hospitals can not take the change of not having material, but having more than three suppliers for the same product is too much because it does not allow to reach neither scale economies nor better negotiations with the suppliers.

Proposal III
To form a working group with professionals of health, doctors and nurses, because they are the ones who use the materials, and the professional of supply, as they have the knowledge to make better agreements and choose the best supplier, with the aim of reviewing all references. This way it would be possible to reduce the number of references, and also decrease the number of suppliers, reducing the purchasing and inventory costs. The use of information and communication technologies (ICT) is also a very powerful tool in inventory management. Many hospitals, including Faro Hospital, are already using it, but they are not taking full advantage of it due to several reasons, for instance, there is not a common database to all the products because the designations are different. As soon as this problem is overcome, the advantages that can be raise from it are immense because the hospital will have his processes facilitated, namely in terms of controlling the stock. Moreover they can take advantage of models like the *vendor managed inventory (VMI),* where the supplier is the one who do inventory management instead of the client.

3.5 The picking

There are two main ways of doing the picking of the materials, the picking per client, and the picking per line of product.

The picking per client, considering the department as clients, assumes that each order is unique and all the products and quantities ordered must be satisfied. All the products are accumulated in a box or trolley that will be then delivered in the department. In this kind of picking, the responsible for the order do not move on to another order without fulfil the previous. The sequence of picking is done by client, when one is filled it is then possible to move to the following.

The picking per product is different, because it conciliates various orders of various departments and determinate which are the products that are identical, when the orders have repeated products, the worker picks the total ordered quantities and put everything in a box or trolley, only later separate the quantities between each client (department). The advantage is that the worker in charge of the picking only have to go once to each place, preventing a number of journeys to the same place.

Doing the picking is a very repetitive task so many models were developed with the objective of raising its productivity, reducing the resources, improving the timings and diminishing the errors in the service. A way of making this process easy, is with the help of information systems that calculate the better route to do (inside the warehouse), depending on the position of the products that need to be picked. Moreover, instead of using paper, that is the more traditional way of doing this, the worker in charge of this task should use an instrument where are defined the products to be picked, the quantities, where are they and the best route to make the picking. Furthermore if this instrument has barcode scanners, at the moment the product is picked, the system is informed and alerts if there are errors. But, to make this possible it is necessary that the warehouse is totally organised, with all products identified and more important, that a good information system exists behind this.

In Faro Hospital, the picking is done by client, each department order is fully satisfied and only then the worker in charge of the picking can fulfil the order of other department. For each department are determined levels of consumption that are in a sheet of paper, which is followed by the person responsible for the picking, filling a trolley with all the products that are required for each department.

Figure 6: Trolley after the picking by client. Source: HF, EPE

Proposal IV
To use an electronic information system and barcodes instead of sheets of paper, to help in the picking, counting of the materials and also planning the routes. This system brings many advantages, not only during the picking but also at the time of the reception and exit of the materials from the warehouse, as it also provides a real time update of each product's levels in each warehouse.

3.6 Internal distribution

In the context of internal distribution of clinical consumption materials in the departments there are different systems that can be applied.

The periodic review model requires that the levels consumed in each department during a determined period, that usually is more than a day and less than a week, are

determined in collaboration with the responsible of the medical department and with the supply service. The frequency of the replenishments is also accorded previously. When the levels for each product are established, is created a local for their storage that is identified by a label with its correspondent code of the article, its designation and the level of stock. The process of consumption is initiated with the placing of the quantities of all articles in the level that was established in the correspondent place. At the day that is scheduled, a worker of the warehouse goes to the medical department with the respective document where the levels are established, and in the local of warehousing he proceeds to the count of all the existent units of each article, registering it in the document as well as the difference between the existent and the level predetermined. Afterwards the worker goes to the central warehouse and makes the replenishment of these differences, registering in the respective document the quantities that had used. Finally returns to the local where the materials are consumed, where he made the reposition of the levels.

At this point, is important to refer that the usage of barcodes to make the identification of articles is associated to a specific software, that is compatible with the software used in the inventory management. This makes all the process more efficient and reduces the number of errors that can occur in the identification of the articles and registration in the documents. It is only necessary that the labels used to identify the material have barcodes and, that a database, with the information relative to the level of stock for article and the local of consumption, has been constituted.

The scanning can implicate an additional investment, depending on the number of portable scanners that is necessary to acquire and, on the software of connection to the program of inventory management that exists.

The application of this method can bring many advantages. It reduces the volume of stock and the value of the stored stock in roughly 50% (Gonçalves, 2001), it gives more freedom to the nursing and auxiliary personal because they are no longer the responsible for the management, transport and storage. Furthermore, it improves the storage of the clinical consumption materials and facilitates its control, and also regulates the exits of the warehouse which is important to boost the inventory management.

There is also another possible method, the system of supply through an electronic controlled closet.

This system involves a set of closets that are placed near the users, where the products are stored and ready to be consumed. The opening of the closets is electronically controlled through a specific software that does the inventory management and the replenishments, assuming a total integrated system for all the hospital. The software communicates with the user through a graphical screen.

The closets are the main component of the system and present various possible configurations depending on the space available. The mechanical and the electronic elements are independent by drawer or door of access, allowing the existence of levels of access.

For the clinical consumption materials there are three possibilities:

- General opening of the closet, average control level: the user identifies himself towards the system and select in the control panel, the patient to whom is destined the product. All the doors and drawers of the closet open up. By selecting in the screen the desired product, the system makes its automatic location through a flashing light. Every operations are registered in the system.

- Opening of sections (doors or drawers), maximum security level: once the user is identified and the patient is selected, a list of the available products in the closet appears on the screen. From this list, the desired product and quantity can be chosen, and then the system gives access to its location, maintaining the rest of the doors closed.
- Closet without doors with identification of the products, minimum control level: it is the cheapest option, and is indicated to the products with less financial weight which occupy a lot of space. Although functioning like an open system, the user still have to select the patient after identifies itself and choose in the screen the products and the quantities.

This system can bring many advantages: it makes an effective control of the stock, the products are always available with a control of access, and it reduces the stocks. There is also an interconnection between the inventory management and both the financial and production areas, which provides information in real time. This system is easy to expand.

The disadvantages are related with the big investment in the system and the closets. The system's optimisation requires an integrated computerisation of the hospital. It is also important that all the professionals accept the control imposed by this new technology.

Again, looking to Faro Hospital and analysing the cardiology department, it is possible to see that the periodic review model is used.

The levels were previously accorded between the heads of nursing of each medical department and the responsible for the supply service. Then, an average for a reposition was calculated, twice a week (Monday and Wednesday) in the cardiology department, specifically. A worker from the supply service responsible for the cardiology department

counts all the existent units of each article and registers them. The quantity of articles needed to make the reposition is calculated by the difference between the existent and the predetermined level.

Usually this can take 45 minutes and is not an exact process, not only because the levels are outdated, but also because it is done by just an approximation glance. Afterwards, this worker can go to another medical department to do the same task, or go directly to the central warehouse to do the picking of the necessary materials. On average, the picking takes 40 minutes, depending on what products are needed and where are stored. When all the essential material for the cardiology department is in the trolley the worker goes to the department again to make the reposition of the materials. This process can take up to 30 minutes because it requires the use of two different elevators. Depending on the queue for the elevator and if all the materials fit in just one trolley, the time can vary and, sometimes, there is the need to make two trips.

The central warehouse is inside the hospital building, making the movements between the warehouse and the medical departments easier. However, this method has some setbacks: the warehouses that exist in each medical department are not used as advanced warehouses, which means that when the materials leave the central warehouse they have already been given as consumed when, in fact, they have just been moved from one place to another. Another setback is that no one in each medical department, in this case the cardiology department, is responsible for the replenishment of the materials, meaning that there is no kind of confirmation if the materials are present in the right quantities and in the right place.

Figure 7: Small warehouse in the cardiology department. Source: HF, EPE

Proposal V
The small warehouses should be considered as advanced warehouses. The stock levels of the products in each small warehouses should be reviewed at once, as they are outdated. The identification of the products should be made by a label with barcodes readable by an optical scanner. Each time that someone picks a material scans the label so that the system knows in real time the consumption of each product and the inventory level is always up to date. In this way it would be possible to accurately know how much is spent in each department and make better forecast for future needs. For the system to work it would be necessary to explain the it's importance to all the users and to appoint in each service someone to control the correct use of the system.

4. Conclusion

After analysing the supply chain of hospitals and its logistics processes, in particular of Faro Hospital, it is possible to conclude that the biggest difficulties are in the areas of purchasing, negotiation, inventory management and internal distribution.

The negotiation processes are new for public hospitals, since previously they bought all the materials from a fixed list where the negotiation did not exist. Now, it is possible to choose and buy to the best supplier. But even so the processes are very long and complicated. In order to facilitate the negotiations and to reap the benefits of economies of scale, more partnerships with suppliers should be made. Group Purchasing Organisations are also a solution to buy common materials with better conditions.

The warehouses, where the materials are stored, should be a competitive advantage rather than a problem. In the case of Faro Hospital, a proposal was made, to change the warehouse from the current installations to a hangar that was recently built. This way there would be more storage space and a better layout, optimising the routes when storing and picking.

There are many solutions to inventory management (JIT, scheduling, Kanban, etc), and information technologies (barcodes, RFID) that facilitate the tracking and management of products, these are fully developed and implemented in other industries. By comparison the health sector is still unexplainably lagging behind.

The physical distribution of the materials is of utmost importance, since the products have to be in the right place at the right time at the right quantity. The lack of product could put patients lives in danger. Using the combination of a central warehouse and smaller advanced warehouses with real-time inventory management, it would be possible to avoid ruptures or excess of items.

So it is the time to change the idea that the public health sector is different from the other industries, because although the objective is not profit, it is essential to use the economic resources wisely to be capable of treating more persons with the same amount of financial resources.

In this area the hospitals could learn and adapt the widely used techniques in other industries to do the logistics and inventory management, reducing waste and improving the quality of services provided.

Finally, as a result of this work project, some proposals concerning Faro Hospital, were made, namely:

I - More consignment contracts with the suppliers;

II - To use the existent hangar as the unique consumption materials' warehouse;

III - Employ inventory management techniques widely used in other industries;

IV - To use electronic information systems and barcodes;

V - Create advanced warehouses inside the main hospital departments.

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4. Appendices

General description of Faro Hospital and it's activity characterization

Faro Hospital is a central hospital that provides health care services to a population of 515.118 habitants, it is a reference center for the whole population of Algarve. During the year of 2008 the number of inpatients were 19.641, the number of emergency cases were 136.195 and the number of surgeries were 6.639.
It was built to substitute the "Hospital da Santa Casa da Misericórdia" and started its activity at the fourth of December of 1979.
Over the years, the premises of the hospital suffered various adaptations of structure and organization that had change the capacity of care response with an increase in the level of complexity and subspecialisation of the services. The total area of the Hospital is 46.500 m2 and is composed by three buildings, the main building have 8 floors divided by areas. The Emergency Services and the Operating room, are situated in the main building as the Physical Medicine and Rehabilitation, the Pathologic Anatomy, the Radiology, the Central Sterilization, the Blood Department and the Analysis Laboratory.

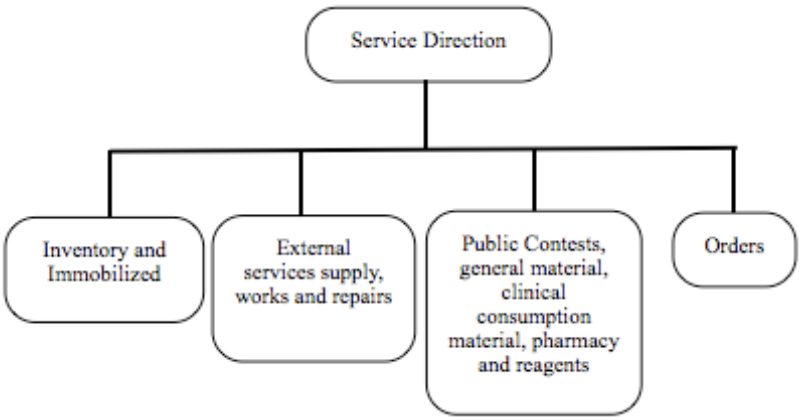
This Hospital has a capacity of 488 inpatient treatment beds divided by different departments, according to the table represented below:

Departments	Capacity
Medical Departments	201
Medicine I	33
Medicine II	31
AVC Unit	5
Cardiology	18
Dermatology	7
Gastroentrology	14
Physical rehabilitation medicine	3
Nefrology	11
Neurology	12

Departments	Capacity
Pneumology	22
Psychiatry	35
Medical Oncology	10
Surgical Departments	154
General Surgery	57
Plastic Surgery	4
Neurosurgery	8
Ophthalmology	5
Orthopedics	58
Otorhinolaringology	6
Urology	17
Obstetrics/Gynecology	68
Medical Pediatry	28
Intensive Unit Care	37

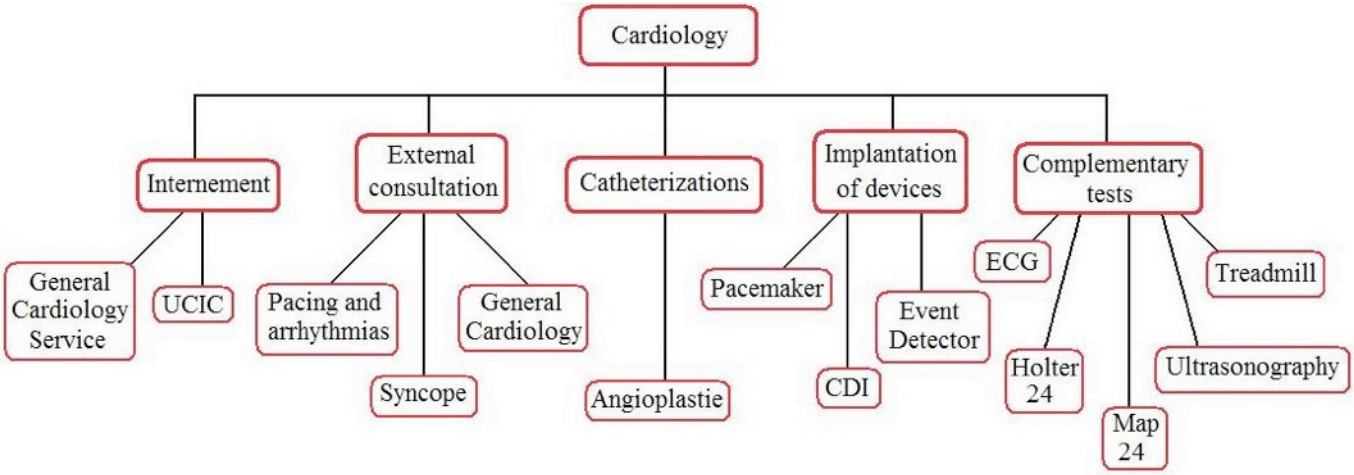
Faro Central Hospital has an Polyvalent Emergency Service that includes the General Emergency, the Gynecologist and Obstetric Emergency and the Pediatric Emergency.
The outpatient consultation is situated in other building opened in 2004, there is also an heliport that is situated on the top of this building.
In another building is the administration and the administrative services
In an independent building are installed the Department of Psychiatry and Mental Health and also the pulmonary diseases department.

General description of the supply service
In this hospital the supply service is the responsible for the development and implementation of the processes of acquisition of the goods and services necessary to the hospital's normal activity, and it is also responsible for the inventory management and storage of the clinical consumption materials.
This service is divided in four main areas as the chart represent.



There are also services that are outsourced like the laundry, the alimentation, the cleaning, the security and the gardening that are done by external enterprises.

Cardiology department



The activities done by the Cardiology department can be divided in 5 main areas: the Inpatient Care, the Outpatient Consultation, the Catheterizations, the Implantation of devices and the Complementary Tests.

The Inpatient Care is when the patient needs to stay in the hospital while under treatment, this activity is divided in the General Cardiology Service and in the Coronary Intensive Care Unit (UCIC). This activity is growing over the last years, in the last year, there were 2220 inpatients in the General Cardiology Service and 1135 of those have been in the UCIC.

The Outpatient Consultation is when a patient receives medical consultation. This activity is divided in General Cardiology Consultations, Pacing and Arrhythmia Consultation and Syncope. All them are divided in first and second, the first ones are the more important for the hospital because is the number of patients that is capable to attract, the more patients a hospital has, the more money it receives. The General Cardiology Consultations had diminished from 2007 to 2008, in the last year, there were 654 first consultations and 1158 second consultations. The Pacing and Arrhythmia Consultations are growing, in 2008 the total number of first and second consultations were 1697. The Syncope Consultation only started in the year of 2007, in 2008 the total number of consultations were 200.

Catheterizations are different procedures that are performed inserting a catheter into a vessel of the heart. The angioplasty is a therapeutic procedure to treat narrowed or obstructed coronary arteries and consists on placing a “tube” in the artery. The number of angioplasties has risen in the last five years. In 2008 the total number of patients treated using this procedure were 625 and the number of “stents” used were 1077; a “stent” is a “ metal tube” that is placed in the coronary arteries during an angioplasty.

The Implantation of Devices is when a battery is implanted in the patient. There are three kinds of devices, the Pacemakers, Event Detectors and CDI’s which are defibrillators. The total number of implanted devices has risen during the years; in the last year, 232 Pacemakers, 15 Event Detector and 23 CDIs were implanted.

Complementary tests are all the examinations that are made to patients to measure their health condition. All the examinations, ECGs, Ultrasonography, Treadmill, Holter 24 and Map 24, rose in the last years.
The GDH (Grupo de Diagnóstico Homogénio) is a way of classifying medical procedures. The next table presents the main procedures done in the cardiology department.

GDH	Procedure	Price
116	Outras implantações de pacemaker cardíaco permanente	4.197,68 €
117	Revisão de pacemaker cardíaco, excepto substituição do gerador	2.111,34 €
118	Substituição do gerador de pacemaker cardíaco	4.005,22 €
121	Perturbações circulatórias com enfarte agudo do miocárdio e/ou complicações major, alta vivo	5.953,96 €
808	Procedimentos cardiovasculares percutâneos, com enfarte agudo do miocárdio, insuficiência cardíaca ou choque	6.409,49 €
851	Implantação de desfibrilhador cardíaco, sem cateterismo cardíaco	31.255,39 €
852	Procedimentos cardiovasculares percutâneos, com stent não eluidor de fármacos, sem enfarte agudo do miocárdio	3.769,08 €
853	Procedimentos cardiovasculares percutâneos, com stent eluidor de fármacos, com enfarte agudo do miocárdio	6.206,79 €
40085	Trombólise coronária, via endovenosa, outros trombolíticos	1.510,60 €
40301	ECG simples de 12 derivações	7,50 €
40315	Prova de esforço em bicicleta ergométrica ou em tapete rolante com monitorização electrocardiográfica contínua, registo de ECG em cada estádio	36,80 €
40405	Registo de Holter até 24 horas com análise interactiva do perfil rítmico e do segmento ST, podendo incluir variabilidade da frequência cardíaca	52,20 €
40550	Ecocardiograma com estudo Döppler	63,70 €

Document with the levels for reposition

CARDIOLOGIA 11102 DATA__/__/__

Local	Designação	Código	Nível	Fornec.
1	Tubo Aspiração	290152002	50	
2	Seringa 2 peças 10ml	230100003	300	
3	Serinda 2 peças 5 ml	230100002	200	
4	Seringa 2 peças 2 ml	230100001	200	
5	Seringa 2 peças 20 ml	230100004	80	
6	Seringa Vesical 100cc	230103001	15	
7	Sistema Medic. Diurese 500cc	2300040003	10	
8	Tubo Oxigénio esteril	290152004	40	
9	Luva Esterilizada 6,5	220061002	50	
10	Luva Esterilizada 7	220061003	50	
11	Luva Esterilizada 7,5	220061004	50	
12	Sistemas Soros c/ Arejador	230039001	50	
13	Luva N. Est. **Sem pó** média	290151017	600	
14	Saco recolha Fluidos	230033004	15	
15	Toucas	290148002	40	
16	//////////////////	230039007	3	
17	Seringa Insulina	230101003	40	
18	Seringa Gasimetria	230101004	30	
19	Luva Esterilizada 6	220061001	10	
20	Luva Esterilizada 8	220061005	20	
21	Cateter Venoso Ch 20	230021001	150	
22	Cateter Venoso Ch 22	230021006	100	
23	Mascara Cirurgia	230098002	100	
24	Perfurador Soros	230131001	70	
25	Cateter Termod. 7F	230021009	6	
26	Torneira 3 Vias	290147001	150	
27	Rampa 4 Torneiras	290034001	15	
28	Sistema 797	230140001	20	
29	Avental plástico	290131002	100	
30	Algodão Hidrofilo	210005002	4	
31	Seringa P. Bomba Infusora 50cc	230100011	50	
32	Cateter Subclavia 14G	230092003	3	
32	Cateter Subclavia 16G	230092009	3	
33	Cateter Central 2 Vias	230092014	3	
33	Cateter Central 3 Vias	230092015	3	
34	Sistema Bomba Secura	230151002	50	
35	Compressa 7,5x7,5	210006002	1200	
36	Saco Urina c/ Torneira	230036001	100	
37	Algalia Silastic Ch 16	230014005	5	
37	Algalia silasticCh 18	230014004	5	
37	Algalia silastic Ch 20	230014002	2	
38	Lamina Tricotomia	220047001	40	
39	Algalia Folley Ch 16	230007005	10	
40	Algalia Folley Ch 18	230007004	10	
41	Algalia Folley Ch14	230007006	3	
42	Algalia Folley Ch 20	230007003	3	
43	Algalia Folley Ch 22	230007002	1	
43	Algali Folley Ch 24	230007001	1	
44	Placa Desfibrilhação	260006011	20	
45	Copo Recolha Urina	250052001	15	
46	Tubo Colheita Sangue Gel	250011012	150	
47	Tubo Hemograma Edta	250024003	150	
48	Tubo Plastico Citrato	250011001	150	
49	Tubo Endot. Oral Nasal c/ Cuff 7mm	230043007	10	
50	Tubo Endot. Oral Nasal c/ Cuff 7,5mm	230043008	7	

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51	Tubo Endot. Oral Nasal c/ Cuff 8mm	230043009	5	
52	Tubo Endot. Oral Nasal c/ Cuff 8,5mm	230043010	5	
53	Cateter Prolongador 100 cm	230093005	75	
54	Papel Electrocardiog. 5 Cm	240008002	20	
54	Papel Dinamap TS 6 cm Largura	240008023	6	
55	Electrodo Adulto	240028002	500	
56	Penso 6x7	210027010	100	
57	Sonda Gastro Duodenal N. 14	230050003	10	
58	Sonda Gastro Duodenal N. 16	230050002	5	
59	Sonda Gastro Duodenal N. 18	230050001	5	
60	Sonda Succão n.14	230059003	20	
60	Sonda Succão n.16	230059002	15	
61	Sonda Oxigénio ch 10	230054005	10	
62	Sonda O2 Binasal	230054001	30	
63	Sonda Rectal Ch 22	230055004	5	
64	Penso 10x9	210027016	20	
65	Penso 15x9	210027007	10	
66	Penso suporte Aulha 7x9	210026002	15	
67	Adesivo Comum 2,5 cm	210002003	6	
68	Adesivo Comum 5 cm	210002001	6	
69	Adesivo Anti. Alerg. 2,5 cm	210001002	5	
70	//////////////////////////	210003001	1	
71	Cateter Venoso Ch 18 - 45 mm	230021002	10	
72	Cateter Venoso Ch 16	230021003	10	
73	Cateter Venoso Ch 14	230021004	10	
74	Tubo Guedel n. 3	230063002	5	
75	Tubo Guedel n. 4	230063001	5	
76	Agulha 40x11	230066016	300	
77	Agulha 25x8	230066002	300	
78	Agulha 12x4,5	230066031	200	
79	Sutura poliglic. 2/0 Cilindrica 25 mm	220039003	12	
80	Seda 2/0 Lanceolada 35 mm	220043043	24	
81	Penso Rápido	210025004	100	
82	Espatula Madeira	230031001	100	
83	Colector Urinar 30 mm	230075004	5	
84	Colector Urinar 32 mm	230075006	5	
85	Tubo Esteril c/ rotulo 40 CC	250011007	5	
86	Tubo Latex 200	290151001	10	
87	Dedeiras	290135001	100	
88	Sistema Micro Gotas	230104001	30	
89	Sistema Soros Avi	230039015	50	
90	Conj. Monit. Pressões Linha Arter.	230102003	5	
91	Lanceta Minilet. p/ Glucolet	250006003	40	
92	Lamina Bisturi Est. 24	220059009	100	
93	Lamina Bisturi Est. 11	220059002	100	
94	Cobertura p/ termometro	290161006	210	
95	Lanceta Descartavel	250006001	100	
96	Tubo Heparina	250024001	50	
97	Conexao y	230095020	10	
98	Tampa Algalia Esterilizada	290006002	10	
99	Cateter Venoso 16 g - 17 Cm	230021010	3	
100	Kit Introdutor 7F	230120001	2	
101	Kit Introdutor 8F	230120002	2	
102	Adesivo Hipo. 15 Cm (MEFIX)	210045002	2	
103	Ligadura Elastica 10 Cm	210017001	1	
103	Ligadura Elastica Adesiva 10 Cm	210016003	15	

CARDIOLOGIA 11102 DATA___/___/___

104	Ligadura Algodão 10 Cm	210011003	5	
104	Ligadura Algodão 5 Cm	210011004	2	
105	Ligadura Cambric 10 Cm	210012001	10	
106	Filtro Humidificador 24 h	230032008	25	
107	Luva Palhaço Não Esteril	290037002	300	
108	Placa Pacemaker s/ Desf. Adulto	250006005	6	
109	Placa Pacemaker c/ Desf. Adulto	250006008	6	
110	Adesivo Hipo. 10 cm	210045004	4	
111	Luva Palhaço Esteril Medias	290037003	200	
112	Harmonio	290154002	10	
113	Tampa Torneira 3 Vias Esteril	290006003	100	
114	Cateter Arterial 20 G	230027006	5	
115	Extractor Mucosidade Ch 14	230080001	3	
116	Calcanheiras	290043001	4	
117	Saco Urimeter 2000 RTV	230036007	10	
118	Camara Expansora C/ Valv. p/ Aspir.	290154007	2	
118	Camara Expansora Com Mascara	290154006	2	
118	Imobilizador Membros	290041001	6	
119	Sistema Admin. Sangue c/Filtro	290037003	8	
A	Mascara Venturi	290092012	10	
B	Esponjas	290028003	200	
C	Fralda Grande	290025001	80	
D	Resguardo 60x60	290025005	40	
E	Resguardo 80x180	290025003	25	
F	Fralda Média	290025002	80	
G	Contentor 1,5 L	290058001	15	
H	Urinois	290061001	300	
I	Arrastadeiras	290060002	200	
J	Compressas Esteril. 10x10	210008002	1000	

Methods for internal distribution

Figure 8: PDA. Source: HSM

Figure 9: Optical scanner. Source: HSM

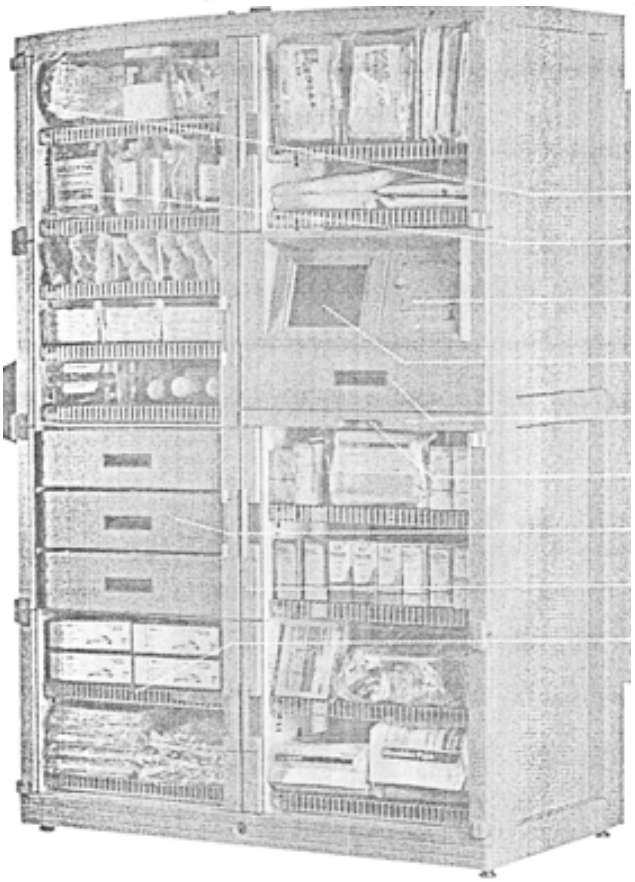

Figure 10: Electronic closet. Source: Gonçalves (2001)